



RFID implementation for scan out of goods trains in the warehouse using the SLFF (single lane free flow) concept

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Abstract

The warehouse is an important part of the production plant, providing a place for temporary storage and retrieval of raw materials, semi-finished goods, or finished goods. Automotive industry has a warehouse that is very important in the process of distributing goods to all production sections. Currently, the process of recording the train of goods leaving the warehouse at Automotive industry is done manually, which can take more time, effort, and potentially input errors. To minimize the occurrence of errors in inputting, RFID (Radio Frequency Identification) technology can be used for the process of data collection of outgoing freight trains, by scanning the RFID Tag that has been installed in each train. This RFID Scan system is designed using a Node MCU Microcontroller with an input RFID RC522 Reader sensor to scan the ID data on the RFID Tag. Goods train data that has passed the scan out process will appear automatically on the monitoring website and be collected through the database. With this RFID Scan system, the preparation team or related parties can record freight trains that have left more effectively and help increase time efficiency.

Keywords: RFID, SLFF, Warehouse, Scan out

1. Introduction

Warehouse is a place for storing and retrieving supplies of raw materials, semi-finished goods, or finished goods needed and produced by the factory. In the production process, the warehouse is very important to support production and distribution of goods. At Automotive industry, the warehouse has a vital role in distributing goods to all production sections. Currently, the process of collecting data on goods trains leaving the warehouse is still done manually, which can take longer, more energy, and has a greater potential for input errors. To minimize input errors, RFID (Radio Frequency Identification) technology can be used for the data collection process for outgoing goods trains by scanning the RFID tags that have been installed on each train. By using the SLFF (Single Lane Free Flow) concept, speed in data scanning has a big influence on the scan out process, thereby reducing waiting time and helping speed up the process of collecting goods train data. This RFID Scan system is designed using a Node MCU microcontroller with an RFID RC522 Reader sensor input to scan ID data on RFID Tags. Data on goods trains that have passed the scan out process will appear automatically on the monitoring website and be collected via a database. With this RFID Scan system, the preparation team or related parties can record outgoing goods trains more effectively and help increase time efficiency.

2. Research Methods

2.1 Global Management System sat the Warehouse

Warehouse is a place for temporary storage and retrieval of supplies to support operational activities. The difference with a regular warehouse is that a warehouse is a system that provides information regarding the availability or stock of goods, the condition of goods, and the status of goods delivery. This system has an important role in supply chain management (SCM) or the supply chain system which will always be updated and can only be accessed by a number of employees appointed according to regulations.

In general, the warehouse has the function of receiving, storing and preparing components for the production process.

2.2 RFID Scan System in Warehouse

The application of the RFID system in the Warehouse is generally applied during receiving and preparation. When receiving, when the goods arrive at the warehouse, each item can be equipped with an RFID tag so that the receiving team can use an RFID reader to scan the RFID tag on each item received. This data will be automatically recorded in the connected warehouse management system. Meanwhile, during preparation, the preparation team will use the RFID information system to identify and select the items needed according to production planning. After that, the items will be placed on a preparation cart which is equipped with an RFID tag which will later be read by an RFID reader when it passes through the RFID scan out gate which is placed on the outside of the warehouse gate towards the production area.

2.3 Hardware Design

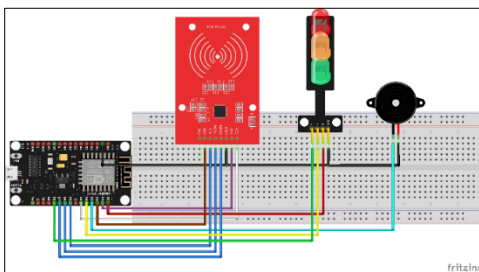


Fig 1: Wiring the RFID system circuit

In designing the RFID Scan system hardware, several components are needed. The main components in this design are the NodeMCU and also the RC522 RFID sensor. In this circuit hardware design, all components are combined on a breadboard and connected to each other using jumpers. After that, each component will be programmed and put together in a circuit (wiring) to produce the desired RFID Scan system performance. Detailed allocation of component pins installed on the NodeMCU can be seen in the table below.

Table 1: Pin allocation on Node MCU

No	Komponen	I/O	Pin NodeMCU
1	Sensor RFID RC522	Input	D1 (RST), D2 (SS/SDA), D5 (SCK), D6 (MOSI), D7 (MISO)
2	Modul LED Traffic light	Output	D0 (Red), D4 (Yellow), D8 (Green)
3	Buzzer	Output	D3 (Positive)

2.4 Software Design

Software design includes creating hardware circuit programs, creating websites and databases. Circuit programming is carried out via Node MCU as the control unit using the Arduino IDE which is compatible with C++ language to make it easier. The Arduino IDE has a library of functions documented in libraries that are available or can be freely downloaded on the internet. The program is designed to be able to process reading data from the RC522 RFID sensor so that the data can be sent to websites and databases. The RFID Scan system can be seen on the figure 2.

The figure 2 explains the performance implementation plan for the RFID Scan System starting from initializing the Node MCU and libraries. Then the Node MCU will be reset to carry out the WiFi connection process. If the SSID and WiFi password that are matched are the same then the internet is connected and if not then the Node MCU will reset again. Once the internet is connected, there is an RFID sensor that will read the RFID Tag data on each trolley and the LED Traffic light and Buzzer Modules will display output as a marker when the scan out is successful. The results of reading the data and the WiFi connection IP will be displayed on the Serial Monitor. Apart from that, the results of reading the data will be displayed on the website by connecting to the web server and will be sent to the database starting by connecting the IP address and Username of the database. In other words, after the data is input to the website, it will automatically be sent to the database.

So that the use of software can be made clearer, a use-case diagram is created. This diagram was created to clarify the interaction between the user or operator and the system, so that the activities occurring in the system can be understood clearly. The following is the design of the use-case interaction diagram on the RFID Scan System website, which can be seen on the figure 3.

The picture 3 explains the design for implementing user or operator interaction on the RFID Scan System website. As shown in the image above, an operator has access to three main pages on the website, namely Preparation, Scan out, and Read Tag ID as well as a database for storage. On the Preparation page, operators can input RFID Tag data related to the identity of the goods trolley being prepared. On the Scan out page, operators can edit and delete RFID Tag data that has previously been input on the Preparation page. Operators can access the Read Tag ID page to monitor the process of scanning out goods trains in the warehouse and monitor the database related to RFID Tag data that has been input to ensure all systems are running well.

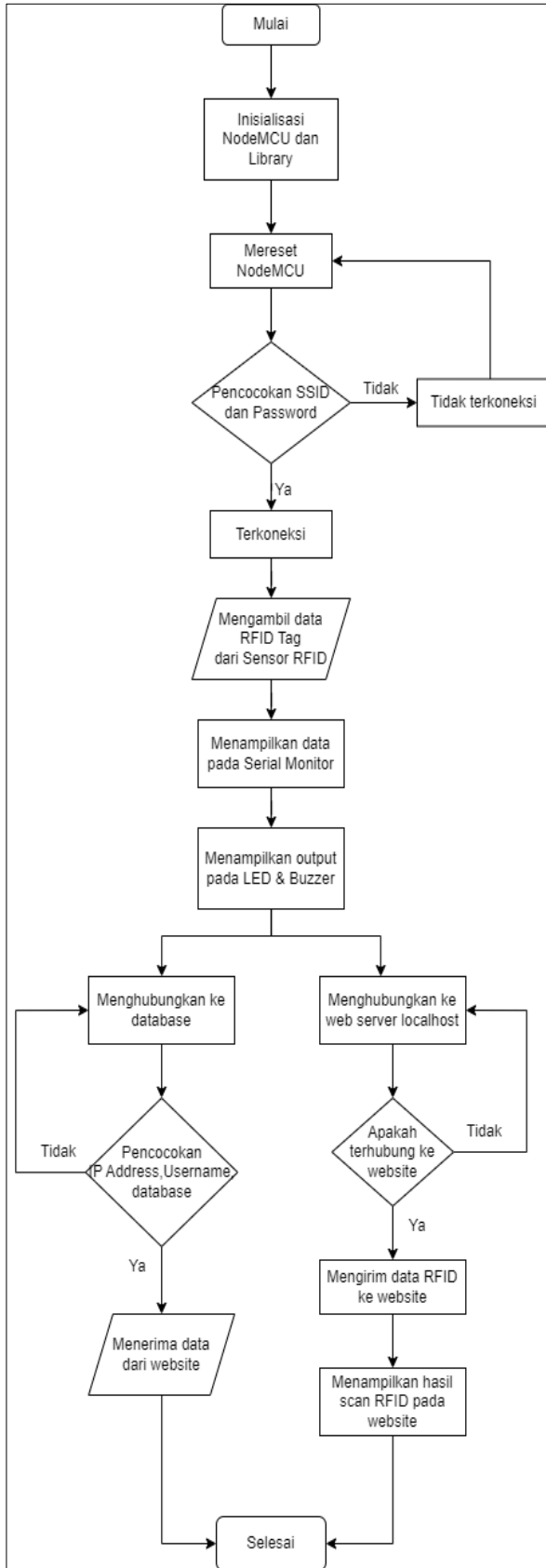


Fig 2: RFID system performance flowchart

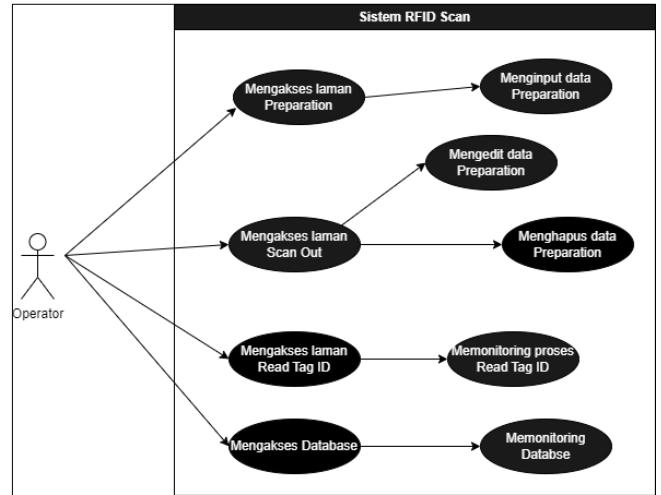


Fig 3: Use-case RFID system interaction diagram

3. Results and Analysis

The results of designing the website display that will be used for monitoring the RFID Scan system are as follows.

3.1 Prototype Testing

After designing the system, system testing is required to test the reliability of the system. Testing for the RFID Scan System uses the black box testing method. This testing method pays attention to the functionality of the system in operation. Through this testing method, data will be obtained on the performance results of each component used as well as the overall performance of the tool when operating.

3.2 Prototype Operations

At the prototype testing stage which is oriented towards prototype operations, a series of prototype operation trials are carried out by simulating event schemes such as those in the warehouse. This operation aims to find out whether the prototype can function as expected and designed, so that this prototype can provide the validation needed for implementation in the warehouse workplace. Some of the trials carried out are as follows.

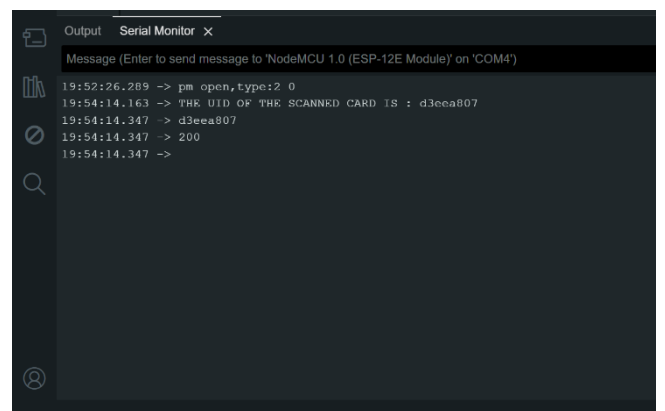


Fig 4: UID reading results on Arduino IDE

Based on the image above, you can see the display of the UID reading results on the RFID Tag. This shows that the UID reading was successfully carried out with the UID form namely 'd3eea807'. Apart from that, the UID was also successfully sent to the server to be displayed on the website. This is proven by the number 200 printed on the serial monitor which shows the response from the HTTP code that the HTTP request was successful so that the UID can be received by the server.

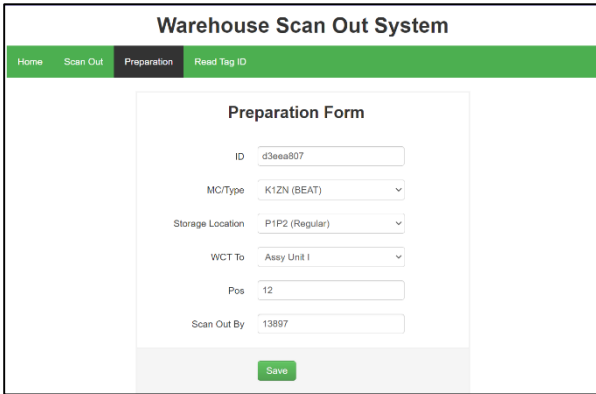


Fig 5: Input RFID data on the Preparation page

In the image above, you can see that the same UID code, namely 'd3eea807', has been successfully displayed on the website, especially on the Preparation page. Next, the UID code has been displayed on the Preparation page and then filled in with the data required for the trolley's identity.

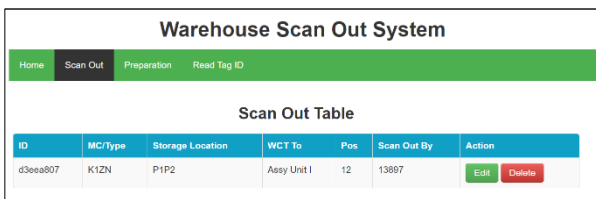


Fig 6: Storing RFID data on the pageScan out

In the image above, you can see that the same UID code, namely 'd3eea807', has been successfully displayed on the website, especially on the Preparation page. Next, the UID code has been displayed on the Preparation page and then filled in with the data required for the trolley's identity.

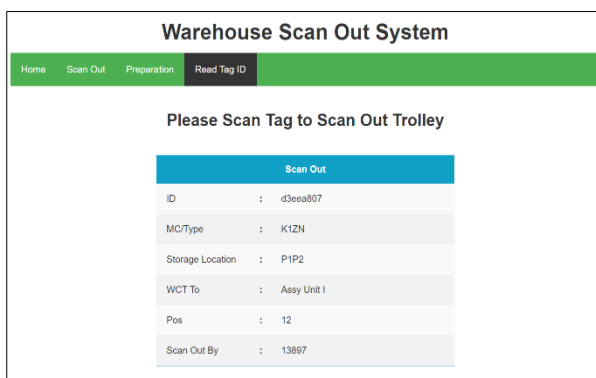


Fig 7: RFIDTag when scanned out on the Read Tag ID page

Furthermore, calling up RFID data using the 'ID' parameter has been successfully implemented to implement a goods train scan out system in the warehouse with a display as

shown in the image above.

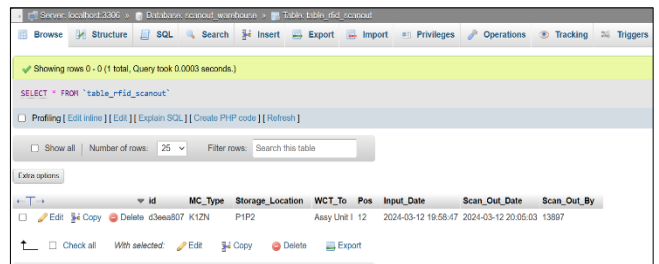


Fig 8: Databases RFID data storage

Then, in the image above you can see that the RFID data that has been input on the preparation page and scanned out as seen on the Read Tag ID page has been successfully sent to the database. The date and time of input and scan out have been set according to the time the RFID data is input on the preparation page and the time the RFID data is scanned out on the Read Tag ID page.

3.3 System Functionality Testing

System functionality testing is carried out to see the suitability of the functions resulting from the design and implementation of each parameter according to the system flowchart. The test results for each parameter show that the entire system can function as desired

Meanwhile, database and website functionality testing is carried out to find out whether the data that has been input on the website will be sent according to the variable data in the database table, such as suitability of ID, MC/Type, Storage location, WCT To, Pos and Scan out By. I have tried changing the data on the website to find out whether it will also affect the database, namely changing the contents of the data that is listed in the database table. If all these tests are successful, then this indicates that the website has successfully connected to the database.

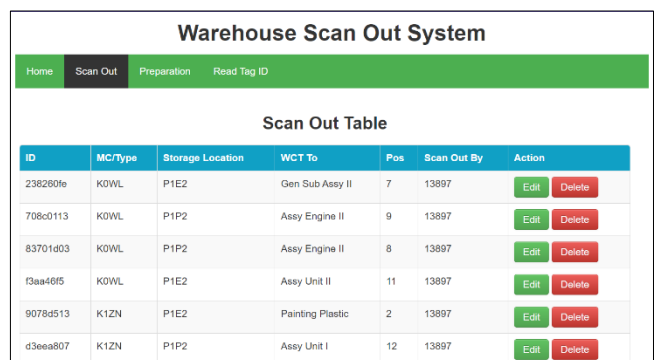


Fig 9: Storing RFID data on websites

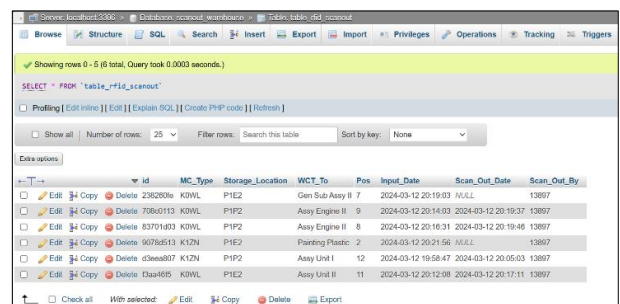


Fig 10: Storing RFID data in a database

Conclusions

1. Designing an RFID Scan System for Scanning Out Freight Trains in the Warehouse Using the SLFF Concept is carried out through several processes, namely, designing the hardware and software for the RFID Scan system, creating a program on the NodeMCU microcontroller including device configuration for system functionality and monitoring system, and ending with testing the RFID Scan system prototype.
2. The main components of this design are the NodeMCU microcontroller, the RC522 RFID sensor equipped with a website for monitoring, and a database for storage.
3. In this design, device configuration is required which includes library configuration, microcontroller pin configuration, WiFi configuration, Web Server configuration, and database configuration.
4. The general description of how this system works is that it follows the SLFF (Single Lane Free Flow) concept, namely a one-lane, non-stop transaction system. In other words, if implemented in a warehouse, this system can read RFID data from freight train tags on each trolley so that it can be scanned out of the warehouse without the need for stops or queuing.
5. The results obtained from designing this RFID Scan system are designing a prototype according to the desired way of working, namely when the RFID Tag on the trolley is read by the RFID sensor, it can display variable data information that has been input on the website which will then be sent to the database.

5. References

1. Muthohir M, Rakasiwi S, Ubaidillah L. Warehouse management system based on radio frequency identification. *Jurnal Teknologi Informasi dan Ilmu Komputer*. 2023;3(1):20-25.
2. Pribadi O, Juliyanti J. Simulation design of a user authentication system using radio frequency identification (RFID) devices with the Internet of Things (IOT) concept. *Jurnal Teknik Informatika dan Sistem Informasi*. 2019;VIII(2):9-23.
3. Raharjo EP, Adidana IKSP, Haryoto K, Rore JB. Analysis of toll payment based on single lane free flow at the Ngurah Rai toll gate in realizing transport sustainability. *Jurnal Teknologi Transportasi dan Logistik*. 2023;4(2):213-228.
4. Sucianto M, Gosal CI, Lisangan EA. Designing a warehouse management system prototype using android-based RFID. *Constellation: Technology Convergence and Information Systems*. 2022, 2(2).
5. Bobi, Krisnadi I. Implementation of RFID gate with warehouse management system; c2022.
6. Budiharjo A, Margarani SR. Study of the implementation of multi lane fee flow (MLFF) on Indonesian toll roads. *Jurnal Keselamatan Transportasi Jalan (Indonesian Journal of Road Safety)*. 2019;6(2):1-14.
7. Wijaya N, Sinuraya EW, Handoyo E. Perancangan aplikasi mobile dan database pada sistem otomatis budidaya maggot berbasis Internet of Things. *Transient: Jurnal Ilmiah Teknik Elektro*. 2023;12(3):92-101.